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OF THE

ROYAL ASTRONOMICAL SOCIETY.

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PROFESSOR J. C. ADAMS, F.R.S., President, in the Chair.

Señor Augusto T. Arcimis, Cadiz;
Lieut. Cyril Corbet, R.N., Cloudesley, Bittern, Southampton;
Lieut. C. B. Neate, R.N., Royal Observatory, Greenwich;
Francis Murray Newton, Esq., Barton Grange, Taunton;
William Philip Snell, Esq., M.A., Belmont, near Havant; and
William E. Wilson, Esq., Daramona, Streete, Rathowen, Ireland;

were balloted for and duly elected Fellows of the Society.

Manila Photographs of the Transit of Venus, Dec. 8, 1874.
By the Rev. S. J. Perry, F.R.S.

I have just received from the Physical Observatory at Manila photographic copies of the solar negatives taken during the Transit of Venus last year, which, I think, may be of some interest to the members of this Society. The original negatives would, of course, be of much greater scientific value, especially if accompanied by full details respecting the methods adopted in the observations, but the copies themselves are still very suggestive.

The first was taken at Ingress near the time of bisection; the second, third, and fourth at long intervals during the transit; the fifth and sixth near internal contact at Egress; the seventh at, or extremely near to, internal contact; and the eighth, ninth, and tenth before and after, but near, bisection at Egress. Clouds prevented any more photographs being taken.

Regarding all the pictures we may remark, that the definition is excellent, and that more attention has evidently been paid in the photography to sharpness of outline in the two circles than to detail of surface. In the first, eighth, ninth, and tenth that

portion of the planet's disk which is outside the solar limb is distinctly visible, the background being decidedly brighter than the surface of *Venus*, but that part of the planet which is on the Sun is somewhat darker than the rest. This is especially noticeable in No. 9.

It seems difficult to overlook a slight increase in the intensity of the light round *Venus* when she is wholly on the Sun; this, perhaps, appears clearest in No. 4, but it is perceptible in Nos. 2, 3, 4, 5, and 6.

No. 7 is exceedingly interesting, as it was taken at the most important moment, and confirms exactly what most astronomers observed at the moment of internal contact; no deformation of the planet, but merely a slight shade where the solar cusps are about to manifest themselves. There is no decided ring of light round the planet, either when on or off the Sun, but only a slight increase of brilliancy when *Venus* is on the Sun, and a general diffused light, on which *Venus*, when off the Sun, is seen projected. It would seem, therefore, that the solar envelopes outside the photosphere produce an effect on the sensitive plate sufficiently intense to manifest by contrast the dark body of the planet. The results also seem to point to a slight actinic power in the general surface of the planet, and a still greater power in its atmosphere.

It may as yet be, perhaps, rather premature to draw any general conclusions regarding the physical results obtained during the late Transit, especially as the most valuable observations are at present under discussion and cannot be published for a considerable time. It may, however, be useful to draw attention to such individual cases as come within our reach, as the opinion of those best able to judge in these matters may thus be elicited, and our many false notions be gradually eliminated, thus leaving a clearer field for the discussion of really important details.

Stonyhurst Observatory,
1875, *December* 8.

On the Posthumous Papers of the late Professor Rigaud.

By Major-General Gibbes Rigaud.

(*Communicated by the Rev. Robert Main.*)

When, in 1839, Professor Rigaud was so unexpectedly taken from among us, there was a great feeling among astronomers that Astronomy had met with a great loss, and that in one particular line, namely, that of Scientific Biography, his loss could hardly be replaced. The Marquis of Northampton, at the Anniversary Meeting of the Royal Society, on November 30,

1839, said *inter alia*, "There was probably no other person of his age who was equally learned on all subjects connected with the history and literature of astronomy."

And his friend, Mr. Manuel Johnson, who succeeded him as Radcliffe Observer, referring to him in a printed reply to some criticisms on the work of the Observatory, spoke of him thus—"You have mentioned one, the late Mr. Rigaud, in affectionate regard for whose memory and in admiration of whose learning I yield to no one. His private virtues are remembered by many of us, and his public services will be remembered as long as Astronomy is a science cultivated amongst men."

Perhaps one of the best records of Professor Rigaud's accuracy and research was made in an article in the *Edinburgh Review* on "Sir Isaac Newton and his Contemporaries," which was published in October 1843, and which, from certain internal evidence, we should think was contributed by Professor De Morgan.

That a man cut off as Mr. Rigaud was should leave work uncompleted behind him is almost a matter of necessity; and it was known that at the time of his death he was contemplating both an edition of Pappus and also a Life of Halley, as a sequel to his *Miscellaneous Works* and *Life of Bradley*—but how far he had proceeded in his researches and lucubrations for this purpose was unknown.

Mr. Rigaud died in 1839, and for thirty-five years his papers remained carefully put away. They have, however, now been arranged, and a full table of contents completed, so that the contents of each parcel can be seen at a glance; and, that they might be accessible to all interested in him or his studies, they have been presented by his sons to the University of Oxford, to be deposited in the Library belonging to the two Savilian Professors of Astronomy and Geometry.

Among the Professor's papers were found large materials for a life of Halley, beautifully and clearly written, as all Mr. Rigaud's papers ever were, and almost ready for the press. That the life of Halley has long been a desideratum in Astronomical Biography is undeniable; but for a whole generation no one had appeared with the love of labour and spirit of research of Mr. Rigaud; it is therefore a matter for great congratulation that these inestimable papers were found, that the University of Oxford have agreed to print the work at their press, and that Professor Pritchard is in possession of all the materials collected, and has undertaken the task of editing them, with a *Life of Halley* by himself. If there were nothing but this to come out of this collection of papers the world might be content; but they are, we understand, very numerous and, what is of great importance, most legibly written, and a time will doubtless come when some one with leisure to work a mine of this sort may have infinite pleasure in finding all the Rigaud papers accessible to him.

We are enabled to give some slight sketch of these papers, which may not be without interest to some of our readers; though those who would have had most interest in looking through the work of one with whom they had been in constant correspondence, such as Bailly, Barnwell, Brewster, have all now disappeared from the scenes of their common labours.

The collection of the Rigaud papers as it now stands consists of eleven volumes of manuscript books, bound and labelled according to subjects, which he kept separate: two are entirely Halley; one Pound; another Bradley; two vols. Hearne; two Horrox, being a very careful transcript of the Greenwich MS. of the *Venus in Sole visa*, made at the time he was assisting Mr. Whatton in his researches for his *Life of Horrox*; for which, among other things, Mr. Rigaud translated the Latin Hexameters of Horrox into English verse.

There are also a good many parchment-bound books full of mathematical work and problems which he here recorded; for his careful diligence, in recording in common-place books the parts of his reading which he felt might at some future time be wanted, was perfectly marvellous. The neatness and method in which he kept his papers was remarkable. Mahogany boards and paper were cut to quarto and octavo sizes, and each paper when completed was sewn together, and when bundles had attained to a sufficient size a new one was commenced. The consequence is that all his work is beautifully preserved and legibly transcribed. It would be impossible for us to give a table of contents of all these bundles, as, in addition to all the books, there are twenty-four bundles, each with its table of contents; but some idea of the extent of these labours may be obtained from the following figures. Of the bundles of quarto size in mahogany boards there are five, and in these there are nearly sixty different papers. In the twelve bundles of octavo size in mahogany boards there are over 200 separate papers, and amongst them a list of all the papers which have been printed, and where his various contributions to the scientific literature of the day are to be found.

There were in an old box many bundles of old letters which have been carefully arranged in guard-books. These have all been arranged alphabetically, according to the names of the writers, and the guard-books lettered and a table of contents made to each, so that reference is easy; and of these letters there are 487.

There is also a guard-book containing an interesting series of 64 autograph letters, written by the most famous men of science of the last century to Mr. Magellan, as his name is always spelt, though the name should properly be written "Jean Hyacinthe de Magalhaens." There is a sketch of his life in the *Nouvelle Biographie Générale*, vols. xxxi.–11, which tells us that he was a Portuguese, born at Lisbon in 1723. He was originally an ecclesiastic, but being fonder of Natural Phi-

losophy than anything else, he came to England in 1764, and died at Islington in 1790. He had various artists under his superintendence, and produced the best instruments of the day. He was made F.R.S. in 1774, and was a member of the Academies of Science of Paris, Madrid, and St. Petersburg.

How this collection of letters passed into the hands of Professor Rigaud there is nothing to inform us; but there they are—long autograph letters on science and scientific instruments, in the autograph writing of such men as Kœstner, Achard, Anisson, Barthélemy, Benyouski, Bernouilli, Boscovich, Cassini, Espinoza, Euler, Fonseca, Gavallon, W. Herschel, Lalande, Landriani, Messier, Turgot, Volta, and many more.

But we think we have now said enough to show that a collection of papers which may be very valuable have been opened, as it were, to any one to whom they are of interest; and we think it would be well if many collections of papers left by men of science were deposited in libraries, instead of being retained in families.

Corrected Mean Solar Times of the Beginning and Ending of the Solar Eclipse of 1875, September 28–29, as observed at the Royal Observatory, Greenwich.

(*Communicated by the Astronomer Royal.*)

The mean solar times of the beginning and ending of the Solar Eclipse as observed at the Royal Observatory, inserted on pages 39 and 40 of the *Monthly Notices* for November, should be diminished each by four minutes, owing to a constant error having been made inadvertently in the conversion of the observed sidereal times into mean solar times. It is considered, therefore, advisable to reprint the corrected resulting mean solar times of the beginning and ending of the Eclipse, to be substituted for those on pages 39 and 40.

Observations of the Beginning of the Eclipse.

	Instrument.	Clock or Chronometer.	Mean Solar Time. d h m s	Observer.
(*a*)	E. Equatoreal	Earnshaw	28 23 26 7·1	D.
(*b*)	Altazimuth	Graham 1	23 27 10·8	L.
(*c*)	Simms 4-in. No. 2	Brockbanks 436	23 26 13·8	A. D.
	6-in. Equatoreal	Webb 53	23 27 39·3	C. B. N.
(*d*)	2¼-in. Altazimuth	Dent 2015	23 26 4·0	J. W. N.

Observations of the Ending of the Eclipse.

	Instrument.	Clock or Chronometer.	Mean Solar Time. d h m s	Observer.
(*e*)	S. E. Equatoreal	Sid. Standard	29 0 47 16·6	W. C.
(*f*)	E. Equatoreal	Earnshaw	0 47 16·7	D.
(*g*)	Altazimuth	Graham 1	0 47 21·6	L.
	Lee Equatoreal	Frodsham 3449	0 47 3·6	G. L. T.
	6-in Equatoreal	Webb 5380	0 46 56·1	C. B. N.
(*h*)	2¼-in Altazimuth	Dent 2015	0 47 2·6	J. W. N.

Notes.—(*a*) Very tremulous. Power 140. (*b*) Time recorded uncertain. (*c*) Power 76. (*d*) Probably from 10 to 20 seconds late. (*e*) Power 295. (*f*) Observed through cloud. (*g*) The observation was considered good. (*h*) The last contact may have occurred at the recorded time ± 7ˢ.

The initials of the Observers, W. C., D., L., A. D., G. L. T., C. B. N., and J. W. N., are those of Mr. Christie, Mr. Dunkin, Mr. Lynn, Mr. Downing, Captain Tupman, Lieutenant Neate, and Mr. Nichol.

Royal Observatory, Greenwich,
1875, *December* 16.

Corrected Observations of Coggia's Comet=Comet III., 1874, *made at Dunsink Observatory, Dublin.*

In the observations printed at p. 51 the days are given incorrectly,* the observations should be as follow :—

1874 June	Dublin M.T. h m s	R.A. h m s	Decl. ° ′ ″	Remarks.	Observer.
11	13 41 20·0	7 2 16·63	+69 1 3·4	Very unsteady	Brünnow
12	13 39 10·8	7 4 3·62	68 59 55·3	Very bad atmosphere	„
14	13 34 54·9	7 7 40·17	68 56 11·8		„
15	13 32 47·8	7 9 29·30	68 53 25·0		„
17	13 28 35·4	7 13 9·33	68 45 41·6	Exceedingly bad atmos.	„
19	13 24 22·8	7 16 49·16	68 34 16·2		„
25	13 11 21·8	7 27 25·35	+67 26 8·5		Ball

* The error was in the original MS.—[Ed.]

Ephemeris for determining the Positions of the Satellites of Uranus, 1876. By Mr. A. Marth.

0h G.M.T. 1876.	Ariel. ω	diff.	Umbriel. ω	diff.	Titania. ω	diff.	Oberon. ω	diff.
	°	°	°	°	°	°	°	°
Jan. 1	261·63		290·79		91·95		258·99	
		714·19		434·33		206·74		133·68
6	255·82		5·12		298·69		32·67	
		·18		·33		·73		·67
11	250·00		79·45		145·42		166·34	
		·17		·33		·73		·67
16	244·17		153·78		352·15		300·01	
		·17		·32		·73		·66
21	238·34		228·10		198·88		73·67	
		·16		·32		·72		·66
26	232·50		302·42		45·60		207·33	
		·15		·31		·72		·66
31	226·65		16·73		252·32		340·99	
		·14		·31		·72		·66
Feb. 5	220·79		91·04		99·04		114·65	
		·14		·30		·72		·66
10	214·93		165·34		305·76		248·31	
		·13		·30		·72		·66
15	209·06		239·64		152·48		21·97	
		·13		·30		·71		·65
20	203·19		313·94		359·19		155·62	
		·12		·30		·71		·65
25	197·31		28·24		205·90		289·27	
		·12		·29		·71		·66
Mar. 1	191·43		102·53		52·61		62·93	
		·11		·29		·71		·66
6	185·54		176·82		259·32		196·59	
		·11		·29		·72		·66
11	179·65		251·11		106·04		330·25	
		·11		·29		·72		·66
16	173·76		325·40		312·76		103·91	
		·10		·29		·72		·66
21	167·86		39·69		159·48		237·57	
		·11		·29		·72		·67
26	161·97		113·98		6·20		11·24	
		·11		·30		·72		·67
31	156·08		188·28		212·92		144·91	
		·10		·30		·73		·67
Apr. 5	150·18		262·58		59·65		278·58	
		·11		·30		·73		·68
10	144·29		336·88		266·38		52·26	
		·11		·30		·73		·68
15	138·40		51·18		113·11		185·94	
		·11		·30		·74		·68
20	132·51		125·48		319·85		319·62	
		·11		·31		·74		·69
25	126·62		199·79		166·59		93·31	
		714·12		434·31		206·74		133·69
30	120·74		274·10		13·33		227·00	

	log b	p_o °	Ariel. log a	Umbriel. log a	Titania. log a	Oberon. log a
Jan. 1	9·6425 n	9·20	1·1762	1·3202	1·5351	1·6613
6	·6450	9·14	·1774	·3214	·5363	·6626
11	·6477	9·08	·1786	·3225	·5375	·6637
16	·6505	9·01	·1795	·3235	·5384	·6646
21	·6535	8·94	·1803	·3243	·5392	·6654
26	·6566	8·86	·1809	·3248	·5398	·6660
31	·6597	8·79	·1813	·3252	·5402	·6664
Feb. 5	·6629	8·71	·1815	·3255	·5404	·6666
10	·6660	8·63	·1815	·3255	·5404	·6666
15	·6691	8·55	·1813	·3253	·5402	·6664
20	·6721	8·47	·1809	·3249	·5398	·6660
25	·6750	8·40	·1804	·3243	·5393	·6655
Mar. 1	·6778	8·33	·1796	·3236	·5385	·6647
6	·6804	8·26	·1787	·3227	·5376	·6638
11	·6828	8·19	·1776	·3216	·5365	·6627
16	·6850	8·13	·1764	·3204	·5353	·6615
21	·6869	8·08	·1750	·3190	·5339	·6601
26	·6885	8·03	·1735	·3175	·5324	·6586
31	·6900	7·99	·1719	·3159	·5308	·6570
Apr. 5	·6912	7·96	·1702	·3142	·5291	·6553
10	·6921	7·94	·1684	·3124	·5273	·6535
15	·6927	7·92	·1665	·3105	·5254	·6516
20	·6929	7·92	·1646	·3086	·5235	·6497
25	·6928	7·92	·1627	·3067	·5216	·6478
30	9·6926 n	7·93	1·1607	1·3047	1·5196	1·6458

The values of ω, log b, p_o, and log a are to be interpolated for the times for which the positions of the satellites are wanted. The angles of position p and distances s are then found by means of the equations—

$$\frac{s}{a} \sin (p - p_o) = b \sin \omega,$$

$$\frac{s}{a} \cos (p - p_o) = \cos \omega.$$

The factor b (the sine of the Earth's latitude above the plane of the orbits) being at present negative, the angles of position decrease with increasing values of ω (the satellites' longitudes in their orbits reckoned from the points of their greatest northern elongations, p_o denoting the angle of position of the major axes a of the apparent orbits).

In case polar-coordinates p and s of the satellites are directly observed, these, or equivalent formulæ, or the kindred ones given in *Astron. Nachrichten*, No. 1040, will be found preferable to those adopted by von Asten and Newcomb, not only on account of their greater simplicity, but still more on account of the far greater facility and directness which they afford for computing the differential coefficients in the equations of condition for correcting the assumed elements.

Drawing of the Ring Nebula in Lyra (R.A. $18^h\ 48^m\ 20^s$: N.P.D. $57°\ 8'\ 57''$ [1860·0]). By Edward S. Holden, Prof. Math. U.S. Navy.

(*Communicated by Rear-Admiral C. H. Davis, U.S. Navy, Superintendent U.S. Naval Observatory.*)

The original drawing in pastel (of which a photograph on the same scale is sent herewith—viz. 1 inch = 20″) was constructed from the following measurements taken with the 26-inch Equatoreal of the Naval Observatory, with a magnifying power of about 400 diameters:

1874, June 13. Major axis = 77″·3; minor axis = 58″·0. Observer, Newcomb. N.B. The distances are only for the brighter portions.

1874, Aug. 10. Rough sketch of the nebula and surrounding stars. S. W. Burnham and Holden.

1875, July 7. Angles of position of four lines from bright star A (brightest in a field of 6′) tangent to the outer and inner ovals of the luminous ring.

$AB_2 = 239°$; B_2 on South side of external oval.

$AB_4 = 248°$; B_4 on South side of interior oval.

$AB_3 = 289°$; B_3 on North side of interior oval.

$AB_1 = 303°$; B_1 on North side of exterior oval.

Differences of Right Ascension between star A and tangents to the *preceding* and *following* sides of both interior and exterior ovals, the differences being measured with the micrometer:

A and $n_1 = 22''·58$; n_1 on *following* edge of exterior oval: (n_1 is not the extreme point, but it is where the nebulosity begins to be definite.)

A and $n_2 = 36''·31$; n_2 on *following* edge of interior oval (in this again there is well-marked nebulosity *preceding* n_2, that is, inside the interior oval).

A and $n_3 = 82''·27$; n_3 on *preceding* edge of interior oval.

A and $n_4 = 102''·96$; n_4 on *preceding* edge of exterior oval.

A and $n'_4 = 105''·25$, n'_4 on extreme limit of *preceding* nebulosity.

Observer, Holden.

1875, Oct. 24. Position-angle major axis, 63°·6 ; major axis, 88″·7 (not to the extreme limit) ; minor axis = 60″·1 (extreme). Sketch made of nebula : bright patches seen, and also star inside the ring. Observer, Holden.

1875, Oct. 25. Angle of position and distance of estimated centre of ring from star A, $p = 268°{\cdot}2$; $s = 61''{\cdot}6$.

$AB_2 = 241°$
$AB_1 = 298°$ } B_1 and B_2 as on July 7, 1875.

Observer, Holden.

Pencil sketch made, and from all the measures and sketches a pastel drawing made on a scale of 1 inch to 20″. Lassell's and Winlock's drawings compared with the heavens, Oct. 24 and 25.

1875, Oct. 31. Position of major axis = 63°·1 ; of minor axis, 156°·8.

It is not easy to decide on exact position of minor axis, and the readings are somewhat uncertain. North end of minor axis again seen with several bright points near it. Two bright patches seen. Observer, Holden.

1875, Nov. 2. Position of major axis, 65°·5 ; length, 89″·5 : position of minor axis, 155°·8 ; length, 66″·5. Observer, Hall.

1875, Nov. 6. Position of star A from estimated centre of nebula, 85°·6 ; distance, 61″·9. Observer, Hall.

The drawing represents tolerably well the aspect of this nebula as seen at Washington under average circumstances. The bright patches in the border and the star in the interior are only to be seen in moments of superior definition, but no doubt is entertained as to their existence. The photograph should be held at a distance of about two feet from the eye, in order to represent the apparent size of the nebula as seen in the telescope with a magnifying power of 400 diameters ; and at this distance the relative brightness of the stars and the bright patches is properly kept. In the photograph there are one or two bright points in the nebula beside the central star : these are imperfections. The general aspect is, however, better caught at a distance of about ten to fifteen feet, the picture being shaded from direct illumination.

The only published figures of this nebula of which I have any knowledge are :

I. Herschel's, in *Phil. Trans.*, 1833, plate x. fig. 29.

II. Rosse's, in *Phil. Trans.*, 1844, plate xix. fig. 29.

III. D'Arrest's, in *Description of the Copenhagen Equatoreal*, 1861, plate ii. fig. 5 ; and a good sketch in *Sid. Neb. Obs. Hav.*, p. 334.

IV. Lassell's, privately distributed, and dated Sept. 19, 1860.

V. Winlock and Trouvelot's, in *Astronomical Engravings from Harvard College Observatory*, plate xxxiv.

Beside these, there are several rough sketches of Schroeter's

and Harding's in *Beyträge zu den neuesten astronomischen Entdeckungen*, vol. i. plate vi. fig. 27, and vol. iii. plate ii. figs. 5, 6, 7, and 8.

In these Schrœter chronicles the discovery of a small star very close to the ring, and following it exactly in the prolongation of its axis major (according to his first figure), and also the finding of certain bright patches in the ring itself. Schrœter's star does not exist, unless indeed it be the star A of our observations, as D'Arrest supposes (*Sid. Neb. Obs. Hav.*, p. 334). Schrœter's first figure (vol. i.) places the small star very close to the nebulosity, and his description distinctly says, "dicht unten am Rande entdeckte ich einen ausserordentlich kleinen dunkeln kaum erkennbaren Stern." This is certainly not a description of star A, even with Schrœter's telescopic means. His later figures (vol. iii.) probably show our star A. If they do, it is variable, according to Schrœter's evidence given below; if they do not, his star has no existence at present, as it has been specially looked for.

Herschel's drawing (I.) is of very small dimensions and of no detail.

Lord Rosse's (II.) is very *suggestive* of the present appearance, though by no means a representation of the object as it is seen in the 26-inch refractor.

The wisps of nebulosity, extending outward in all directions, are not seen in the latter telescope, and it is a little curious that that end of the minor axis which Lord Rosse has represented as the best terminated, viz. the *south* end, is precisely that one which to-day, and with the Washington telescope, is least so. The difference between the two ends is here not very marked, but still the north end is sharper and brighter as it is described by D'Arrest, *op. cit.* Lassell's drawing (IV.) represents the general aspect of the nebula better than any other. Some of the details which are to be found in Winlock's (V.) are lacking, as, for example, the great diminution of light at the ends of the major axis; but the star in the interior of the ring is shown, and the elliptical shape of the nebula finely given. Winlock's and Trouvelot's (V.) is on a large scale, and is, in general, very similar to the object in the heavens, but I find the three bright spots or patches far too bright to represent their present appearance in the Washington telescope. The *following* end of the major axis appears to be too sharply terminated; the *preceding* end, however, is in excellent agreement with the nebula. D'Arrest's drawing (III.) is not at present accessible to me.

In Lord Rosse's figure, the interior of the ring is represented to be streaked in bands parallel to the major axis, and this appearance has been noted also by Professor C. Abbe with the Cincinnati Equatoreal (12 inches aperture). This does not represent the appearance as seen at Washington, but it suggests it strongly. This appearance it is not attempted to show in my drawing, but it may best be described as a tendency in the light of the interior

oval to an arrangement in streaks parallel to the major axis, and seen principally in the *preceding* half of the ring, and only under the best conditions.

The first detailed notice of bright patches in the ring itself is by Schrœter, in the work previously quoted, vol. iii. p. 164, *et seq.* and plate ii. figs. 5-8.

1797, April 16. Harding saw a bright patch (β), and he gives a rough sketch, from which I deduce the angle of position of the patch to be about 96°, and the distance from the centre about $\frac{7}{15}$ths of the diameter. (These figures are quite rough, necessarily.) The small star a (so-called by Schrœter) was seen following the nebula.

1797, Nov. 12. The star a was at once plainly seen, while of the spot β of April 16 there was not the least trace. It was for the second time remarked that the interior of the ring is filled with faint nebulosity.

1797, Nov. 19. The star a was again seen. Two sketches were made, one by Harding, and one by Schrœter, which agreed in certifying to the existence of two bright spots a and b.

a : Pos.-Ang. = 339° Dist. = $\frac{5}{15}$ths of diameter.

b : „ = 17° „ = $\frac{6}{15}$ths of diameter.

Their light was *notably* brighter than that of the rest of the nebula, and somewhat twinkling at times. The *preceding* and *following* sides of the nebula were then observed to be, as they are now, somewhat fainter than the rest.

1798, Oct. 27. The *preceding* or *western* side of the ring was seen much darker than the rest, so that the ring looked divided or broken at this point; but on the *following* side this was not the case, as on Nov. 19, 1797.

Again, both the bright spots a and b of that date had disappeared; and in a position-angle of 13°, distance about $\frac{6}{15}$ths, a bright spot c was noticed. This could not be the spot b of Nov. 19, since it was much nearer the edge of the ring.

1798, Dec. 20. The interior of the ring was bright greyish like the sky illuminated by moonlight, and the *western* (*preceding*) and outer portion of the ring itself was not half so bright as the rest of the ring, and as its following border, which, on the 19th of November 1797 had been found equally dark. No bright patches were seen in any part of the ring itself. The star a, which had been seen with difficulty on dark nights, was now plainly visible to both observers in bright moonlight.

Sir William Herschel has a few remarks upon this nebula in Bode's *Jahrbuch* 1788, p. 242. He speaks of it as apparently a ring of stars with a regular and concentric dark spot or space in the midst. "Er ist von ovaler Figur, seine kleine Axe verhalt sich zur grössern wie 83 : 100. . . . Das Licht desselben ist von der auflösbaren Gattung und an der nordl. Seite kann man 3 sehr schwache Sterne erkennen, sowie einen oder zwei am

südlichen Theil. Die Ende der längern Axe scheinen weniger glänzend und nicht so deutlich abgeschnitten als die übrige. . . . *siehe* Fig. 9" [Fig. 9 is a simple sketch of no detail]. Von Hahn in the *Jahrbuch* for 1803, p. 106, has some further observations with a 20-foot reflector. "Ich finde in dem beruhmten Sternring . . merkliche Veränderungen. Vor einigen Jahren war das innre Ring so klar, dass ich . . . in dessen Mitte ein teleskopisches Sternchen unterscheiden konnte. Jetzt zeigen sich . . . . schwache feine Wolken und der kleine Stern ist gar nicht sichtbar. Eine Veränderung ist sicher vorgefallen. Es kann aber auch sein, dass der Ring sein Stelle verändert hat, und nur auf dem unendlich viel weiter als der Ring entfernten Himmelsgrunde, der durchsichtige Ring anders erscheint."

From Sir John Herschel's "Observations of Nebulæ, &c.," in *Phil. Trans.* 1833, p. 462, I extract a few notes regarding this nebula: "Position of longer axis of annulus 57°·0 by micrometer . . . . diameter in R.A. $5^{s}\cdot375$ by a mean of four careful observations. The Star following it is 11^{m}. It follows the centre $4^{s}\cdot31$, and its position from centre is 96°·4 by micrometer. The nebula has a mottled look. [N.B. This mottled look, however, is something quite different from the appearance called resolvable.]"

D'Arrest speaks of it as follows in his *Sid. Neb. Obs. Hav.*, p. 334: "Adspectu floccosa — * 14^{m} (non 11^{m}) seq. in parallelo, * 14^{m} in seq. centrum accurate in parallelo $4^{s}\cdot67$. Margo borealis australi certe lucidior: in ipsa neb. 2 vel 3 fixæ subtilissimæ conspiciuntur. . . . . In limbo boreali eoque certe lucidiore duæ stellulæ satis distincte affulgent; nulla vero intus in annulo." Angul. posit. axis majoris = 58°43′. Axis major = 58°·1; axis minor = $59''\cdot9$.

Secchi (*Ast. Nach.* bd. 43, col. 160) saw, "très bien dans l'intérieur une très petite étoile un peu au-dessous (apparent) (that is, north) de son centre."

Auwers in *Ast. Nach.* bd. 58, col. 375, has the following observations (1862): "Grosse Axe des äussern Ringrandes = $75''\cdot0$ in Pos. 70°·0 Klein = $61''\cdot5$ (2 Tage). . . . Stern $11^{m}\cdot6$ $d = 61''\cdot1$, $p = 87°\cdot1$ (2 Tage): daraus folge $\Delta\alpha = 4^{s}\,84''$."

Dr. H. Schultz, in his recently published "Observations of 500 Nebulæ" (Upsala, 1874), has the following notes on this nebula:—

"1865, August 12. Nebula bluish and strongly granulate; north part brighter. Position of the major axis 57°·9; minor axis, 148°·9. . . .

"1865, August 13. The north part of the ring brightest; strongly granulate, with several not very faint stars seen by momentary glimpses: 2 or 3 stars in the *north-preceding* part and 2 in the *south-following* part of the ring distinctly seen; at the interior margin of the ring 2 stars visible in the *south-preceding*, and one in the *south-following* part. Hahn's star a little *north-preceding* the geometrical

centre, momentarily visible; dull and planetary. All these stars only so momentarily seen that to adjust the micrometer wire upon them was quite impossible. The *north-following* part of the ring very diffuse with nebulous radiations in the direction of the longer axis, which seem momentarily almost to destroy the annular form. The central vacuity not inconsiderably nebulous. . . . .

"1867, August 6. Hahn's central star distinctly seen without effort . . . the *north-following* end only momentarily well defined.

"1870, August 8. . . . Twinkling stellar points at the *north* outer margin, which is best defined." . . .

Lamont's observations of 1838–9, with a sketch, are given in *Annalen d. k. Stw. bei München*, bd. xvii.

My own notes on the bright patches are as follows. They refer specially to 1875, October 24–25:—

"Minor axis more sharply terminated on *north* side: near *north* end of minor axis is a bright patch. The star inside the ring is seen occasionally: it is very near the *south-preceding* corner of a square formed by three stars outside (which are Lassell's Nos. 1, 8, and 5 or 6) and itself. The whole of the interior glistening in points. At the *south* end of the minor axis filaments of nebulosity extend 15″ to 30″ off. These are very faint. The *following* end of major axis is better terminated than the *preceding*. Two brighter spots are seen in the *north-preceding* and *south-following* parts of the ring, and possibly a third in *south-preceding* part. At both ends of the minor axis are several which cannot be located exactly."

With regard to the identity of the star 14^m = Lassell No. 1 with Schrœter's star *a*, I find from Schrœter's first drawing that its distance from the *following* end of the major axis was not more than 4″ or 5″. His subsequent drawings certainly represent our star 14^m; and he refers to this 14^m as if it were the one first seen by himself and Harding on 1786, November 13.

The question is of no great importance, except as to the existence of a small star so close to the ring. As I have said, this star has been looked for, and at present does not exist.

I add a Table containing measures of this nebula, for convenience of reference:—

Date.	Angle of Position.	Distance.	Authority.
		Major Axis.	
1825–33	57°·0	5ˢ·375 (diam. in R.A.)	Herschel.
1837–9	66 22′ (mean of two varying 8°)	68″·4 (Major Axis, m.m.)*	Lamont.
1860	...	89″ („ „ „)	Lassell.
1863	58 43′	78″·1 („ „ „)	D'Arrest.

* In the table, m. stands for *measures*, and m.m. for *micrometer measures*.

Date.	Angle of Position.	Distance.	Authority.
1863	58·43′	$5^s·66$ (diam. in R.A.)	D'Arrest.
	...	$5^s·30$ („ „)	„
1863	70·0 (query 60°·0??)	75″·0 (Major Axis, heliometer)	Auwers.
1865-6	57·9	59″·7 (diam. in R.A.)	Schultz.
1874	...	77″·3 (Maj. Axis, not extreme, m.m.)	Newcomb.
1875	63·6	80″·4 (diam. in R.A., m.m.)	Holden.
„	63·1	88″·7 (Major Axis, m.m.)	„
„	65·5	89″·5 („ „ „)	Hall.

Minor Axis.

1860	...	68″ (Minor Axis, m.m.)	Lassell.
1837-9	...	55″·4 („ „ „)	Lamont.
1863	...	59″·9 („ „ „)	D'Arrest.
„	...	61″·5 („ „ heliometer)	Auwers.
1865-6	148·9	58″·1 (diam. in δ, m.m.)	Schultz.
„	...	58″·8 („ „ „)	„
„	...	56″·5 („ „ „)	„
„	...	56″·1 („ „ „)	„
1874	...	58″·0 (Minor Axis, m.m.)	Newcomb.
1875	156·8	60″·1 („ „ „)	Holden.
„	155·8	66″·5 („ „ „)	Hall.

Star 14^m = *Lassell No.* 1.

1825-33	96·4	ΔR.A. = $4^s·31$	Herschel.
1837-9	88 22′	... ...	Lamont.
1863	" in seq. centrum accurate in	ΔR.A. = $5^s·47$	D'Arrest.
„	parallelo ∴ 90°	ΔR.A. = $4^s·67$	„
„	87°·1	61″·1 (dist., heliometer)	Auwers.
„	...	ΔR.A. = $4^s·84$ (from above means)	„
1865-6	86·8 (computed from m. of $\Delta\delta$)	ΔR.A. = $5^s·22$	Schultz.
„	...	ΔR.A. = $4^s·86$	„
1875	...	ΔR.A. = 62″·8 (m.m.)	Holden.
„	...	$=4^s·99$ (computed from above)	„
	88·2	61″·6 (distance m.m.)	„
„	85·6	61″·9 („ „)	Hall.

In this table I remark the following differences:—

1st, Position of major axis:

Holden—Herschel	=	+6·4°	1825-33
„ —Lamont	=	−3·0	1837-9
„ —D'Arrest	=	+4·7	1863
„ —Auwers	=	−6·6	1863 (query +3°·4??)
„ —Schultz	=	+5·5	1865-6
„ —Hall	=	−1·1	1875

2nd, Length of major axis:

The measures are so discrepant that a comparison will be of no particular value except between instruments of the same class.

3rd, Position of minor axis:

Holden—Schultz	=	+7·9°	1865-6
„ —Hall	=	+1·0	1875

4th, Length of minor axis:

Holden—Lamont	=	+4·7″	1837-9
„ —Lassell	=	−7·9	1860
„ —D'Arrest	=	+0·2	1863
„ —Auwers	=	−0·4	1863
„ —Newcomb	=	+2·1	1874
„ —Hall	=	−6·4	1875

5th, Position of Star 14^m = Lassell No. 1:

Holden—Herschel	=	−8·2°	1825-33
„ —Lamont	=	−0·2	1837-9
„ —D'Arrest	=	−1·8	1863
„ —Auwers	=	+1·1	1863
„ —Schultz	=	+1·4	1865-6
„ —Hall	=	+2·6	1875

6th, Distance of Star 14^m from estimated centre of nebula:

Holden—Auwers	=	+0·5″	1863
„ —Hall	=	−0·3	1875

7th, Difference of R.A. of nebula and Star 14^m:

Holden—Herschel	=	$+0^s.68$	1825-33
„ —D'Arrest	=	$-0^s.08$	1863 (mean of 2)
„ —Auwers	=	$+0^s.15$	1863
„ —Schultz	=	$-0^s.05$	1865-6 (mean of 2)

The above discrepancies, although large, and in some cases apparently progressive, are probably due only to the intrinsic difficulty of the measures, and to the fact that the appearance of the nebula is different in different telescopes.

On the Southern Nebulæ 30 (*Bode*) *Doradûs, and the Nebula about η Argûs.* By C. E. Burton, Esq.

In the month of November 1874, while serving on the Transit of *Venus* Expedition at the island of Rodriguez, several opportunities occurred of studying the nebulæ referred to above with a silver-on-glass reflector of 12 inches aperture. The results of my work in that direction are embodied in the subsequent portion of this Note, and in two of the figures which accompany it.

30 *Doradûs* coming to the meridian at an hour which did not interfere with other work, received most of my attention. Two careful eye-draughts of this nebula, and of the stars involved in it, together with two or three other noticeable stars, were made on the nights of 1874, November 9 and 13. These sketches were combined to form the sketch laid before the Society. There was no time to spend in forming a skeleton chart of the stars upon which the nebula might be laid down, an operation which I was prepared to perform had the opportunity offered itself.

The recent sketch is placed beside a copy of Sir John Herschel's Cape drawing enlarged to nearly the same scale, and semi-reversed as regards the East and West points, I having used a Newtonian reflector.

Change in Nebula.—(1) In the Cape drawing the streak of nebulosity between the North and South loops is highly curved, and concave toward the South. In the 1874 sketch the same streak bends northward at its West extremity, from which springs a very distinct loop curving southward, which does not seem to be indicated in the earlier representation.

(2) In the Cape drawing the bright star involved in the South loop seems to be situate in a very faint region. In 1874 that knot of the nebula was sufficiently bright to render it difficult to distinguish the fainter stars involved in it. See the

Argo nebula for a proof that the bright knot just mentioned was not due to instrumental glare in the faint region round η.

The distant stars and branches of 30 *Doradûs* were hastily put in from rough eye estimates of their position referred to the bright central region. The bright South loop (Herschel) appeared very faint in 1874. There does not seem to have been much change amongst the involved stars, if allowance be made for eye determinations of position as compared with micrometric places, especially places obtained by Sir J. Herschel.

A pocket spectroscope inserted in the place of the eyepiece of the 12-inch reflector showed a strong continuous spectrum crossed by a bright line, estimated to be the nitrogen line of the nebular spectra. The continuous spectrum appeared to be too bright and free from longitudinal streaks to be attributed, even mainly, to the minute stars involved in the nebula.

The Nebula of η Argûs.

The sketch must speak for itself, as I was not fortunate enough to obtain many notes on the nebula. Those which were obtained are as follows: η was considered to be 9 mag. (Herschel's scale) and orange red. It was well outside the bright nebulosity East of the "Lemniscate." (N.B. In the copy of Sir J. Herschel's drawing of the region, η has been placed somewhat too near the vacuity.) The stars in Sir John's drawing have in most cases their counterparts shown in the sketch of 1874. I am disposed to doubt whether there has been any great change in the region depicted during the forty years separating the epochs of the observations. η I thought had not so "hard" a disk as that of the $8{\cdot}5^{m}$ ruby near β Crucis, with which it was compared under the same power, 400 linear, which was used in making all the sketches of the nebulæ described.

Mr. Abbott's drawing of the Argo nebula was at once recognised on making use of an achromatic of 2·75 inches aperture, power 100, with which the "Lemniscate" was utterly invisible.

1875, *Nov.* 12.

Note on a new Variable Star in Capricornus. By J. E. Gore, Esq.

(*Communicated by Mr. Browning.*)

Just north of and a little preceding the 6 mag. star 4 *Capricorni* Sir John Herschel, in the "Cape Observations," describes a red star as "a fine ruby star, perhaps the finest of my ruby stars," and estimated its magnitude at $6\frac{1}{2}$ mag. Failing to see a trace of this star with the naked eye, or even with an opera-glass, I lately examined its place with my 3-inch achromatic and found the star to be only $8\frac{1}{2}$ or 9 mag. and fiery red. The star is marked 7 mag. in

Harding's Atlas (1822) and was rated $7\frac{1}{2}$ mag. by Lalande. If Herschel's estimate of its magnitude was correct, the star must be variable to the extent of at least two magnitudes. It should be watched, as so many of these deep red stars are known variables. Close by *n.f.* is a fainter star of about $10\frac{1}{2}$ mag. As I can find no previous record of any observations on the variability of this star, I propose to name it V *Capricorni*.

On some Old Drawings of Saturn. By C. L. Prince, Esq.

A few years since I obtained from Holland a copy of the whole of the works of Gassendi, which were published at Lyons in the year 1658, three years after his death. Copies of this publication are very rarely met with in England, and are not contained in the catalogues of the libraries of either the Royal Society or the Royal Astronomical Society. The fourth volume is devoted to Astronomy, and I find that between the year 1633 and 1656 are given twenty-one drawings of the planet *Saturn*. As these engravings are, so far as I am aware, the first representations of the planet ever published, I have sent herewith tracings of eight of them,* believing that, if engraved in the *Monthly Notices*, they would prove interesting to many Fellows of the Society as depicting the gradual progression in knowledge of *Saturn's* form as well as the difficulties which must have been encountered by the observer on account of the unsteady mounting and imperfect definition of the earlier telescopes. The following are literal copies of Gassendi's remarks upon each drawing :—

"No. A. June 19, 1633.—Postea circiter decimam cum per varios nubium hiatus Saturnum tubo respicerem, is quasi ovum sericum, seu quo bombyx filo deducto concluditur. Diameter longior (existens ferè secundum longitudinem Zodiaci) vix apparuit minor diametro Venerea, utraque nempe visa est repetita octies aut decies adæquatum proximè diametrum foraminis tubi. Et à parte quidem anteriore ansa, seu appendicula ostensa est confusior ; sed à posteriore exhibita est omnino distinctè ; totumque hâc propè magnitudine et formâ conspectum est ; siquidem interdum corpus Saturni rotundum, neque radiis undique ansas complectentibus visum est ; interdum vero cum ipsis ansis ob circum effusos cincinnos confusius."

"B.—Saturnus telescopio maximo visus est oblongus, et qualis semper aliàs."

* It was not thought necessary to engrave these tracings for the *Monthly Notices*.—Ed.

"C.—Attendere placuit ad formam Saturni, eaque exhibita fuit, non quasi adjunctis orbi medio duobus aliis orbiculis, sed quasi adnatis duabus ansulis interceptis maculis, quasi foraminibus effictæ. Heinc forma ovallina, et ea sanè longiuscula, adeo ut medius quasi nucleus vix superaret trienteno totius longitudinis. Fuit autem nonnihil clarior, candicantiorque ipsis ansis. Longitudo semper protensa secundum eclipticam. Habes utcumque heic effigiatum. Diameter Martis apparuit minor sensibiliter diametro breviore Saturni."

"D.—Visi sunt adhuc distinctius Saturni satellites quasi duo cuculli hac propemodum specie."

"E.—Cùm ad Saturnum telescopio attendissem medius ille circulus albus non est mihi visus planè exquisitus, speciesque fuit prope hujusmodi."

"F.—Saturnus hujusmodi ferè fuit."

"G.—Saturnus sic se propè habuit."

"H.—Vesperi Parisiis Saturnus rotundus apparuit sine satellitibus clarissimo viro Ismaeli Bullialdo, quemadmodum etiam solitarius deprehensus fuit ab ipsomet Amanuensi mensibus Februario ac Junio telescopio majore Dygbeano videlicet, et minore Galileano."

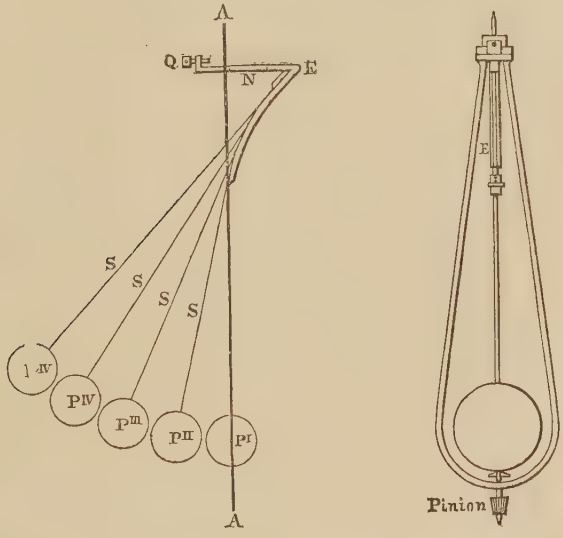
The Observatory, Crowborough,
December 7, 1875.

The Results of some Experiments with Huygens' Parabolic Pendulum for obtaining Uniform Rotation. By R. L. J. Ellery, F.R.S., F.R.A.S., &c.

In the course of some experiments I made about two years since with the view, if possible, of obtaining more uniform rotation for our barrel Chronographs than had hitherto been secured, I was induced to try Huygens' revolving Parabolic Pendulum, which appeared so perfect theoretically that I surmised as the reason it had not been more generally adopted that there must be some great practical difficulty pertaining to the application of the principle.

I was somewhat surprised too, on looking into the literature of the subject, to find so little information; and in the books within my reach in Melbourne no record of any experiments or precise trials of this kind of pendulum for securing uniform rotation. I had, therefore, nothing to guide me in my experiments except the bare principle. The earlier results I obtained were so unpro-

mising that my idea that there must be some fatal practical difficulty in the way was strengthened. Eventually, however, I succeeded in obtaining results, and under trying tests, which satisfied me that the pendulum would, with moderately precise workmanship and careful adjustment, become an almost perfect Governor where the variations of force are not greater than we generally have in chronograph trains, or, indeed, in well-constructed and balanced Equatoreals; and in two Chronographs which I had constructed for the Transit of *Venus* observations, and which were controlled by parabolic pendulums, the rotation of the barrels were practically uniform, even when such a variation of the driving weight was made as to produce a difference of 20° in the arc of the rotating pendulum. When I say *practically uniform*, I mean that, on a barrel rotating once in a minute for two hours and a half, *all similar second marks* were in an absolute straight line, and that with a fine drawing pen and a straight edge a line could be drawn accurately bisecting each second mark; in other words, its secondary rate was not a tenth of a second in two hours. As the principle of Huygens' Parabolic Pendulum may not be generally known among our members, I would beg to refer to these diagrams:—



Let A A be a vertical axis of rotation which can be driven by clockwork acting at the top or the bottom of the axis; from this axis a pendulum P is suspended in such a way that when it hangs vertical the string S lies wrapped over a curved surface E, which forms part and parcel of the vertical axis. This curve

is the evolute of a parabola, whose distance from vertex to focus is half the length of the required pendulum. Now let the axis revolve and the pendulum will fly out from its vertical position, more or less according to its weight and the driving power; the arc described by the pendulum, as it increases its distance from the vertical, will be a parabola, by reason of the string gradually unwrapping from the evolute E. Now, from the properties of the parabola, it follows that the vertical distance between the centre of rotation of the pendulum P and the intersection of the string S with the axis of rotation of the pendulum will remain constant, and therefore that the length of the pendulum remains constant at whatever arc it may rotate.

To practically secure these conditions it is necessary, first, that the evolute shall be properly and precisely made, and secondly, that it shall be so adjusted that the axis of the evolute and involute shall be coincident with the axis of rotation.

The pendulums I had constructed are *half seconds*, that is, rotating once in a second. They are suspended in a hard gun-metal frame, pivoted at top and bottom, the lower pivot resting on an end jewel, the upper pivot supported by a strong cast-iron gallows bracket, and it is driven by a contrate wheel in the clock train engaging into a pivot at the lower end of the frame. The frame is open, of the form shown in the right hand figure, to allow of the middle part of the axis of rotation being clear for the evolute and the pendulum string or rod. The evolute is fixed at M, and is capable of adjustment at right angles to the axis of rotation by a screw Q, the proper position of the curve in the other direction being practically secured by careful workmanship, more especially in the construction of the evolute itself. The pendulum consists of a spherical bob, weighing about $2\frac{1}{2}$ lbs., on a steel rod about one-tenth of an inch thick, and suspended by a long and *exceedingly thin* steel spring secured to the top of the evolute at N. The regulation of the length of the pendulum is done in the ordinary way by a nut at the bottom of the steel rod. The Governor thus made with ordinary care and workmanship is by far the best of any I have had experience of, and has furnished results better, I believe, than any others used with chronographs; at the same time it is simple and inexpensive. In the course of my experiments I found it quite necessary to use the most flexible suspension possible, and the thinnest steel spring made for French clock pendulum springs appears to answer well—it is not liable to twist unless the pendulum is started or stopped suddenly, and this is prevented by a guide for the bottom of the pendulum rod. To get the proper position of the evolute:—If the time of rotation increases with an increase of arc, in other words, if it revolves slower for increase of arc, the axis of the evolute is beyond the axis of rotation, reckoning from the centre of oscillation of pendulum (that is, it is too far away from pendulum bob); and it is too near if it revolves more rapidly for increase of arc. The adjustment

is somewhat tedious, more especially because for every alteration, however slight, of the evolute a large alteration of the length of pendulum is requisite—but it is easily done with a barrel chronograph by increasing and diminishing the driving power and noting the effect, on the rate, of increased and diminished arcs of pendulum. The screw which adjusts the evolute should be moderately fine, as the final touches necessary to get accurate performance will be found very small. I found a good deal of trouble in the course of my experiments from small particles of dust getting between the curve and spring, and it will be found quite necessary to protect the pendulum from this source of imperfect performance.

I had an opportunity of testing one of these chronographs in the presence of Professor Harkness, of the Washington Observatory. It was allowed to go for about an hour, then the weight was doubled for half an hour, and subsequently halved—the arc of the pendulum varying from 10° to 33° under these changes, but the *lines of seconds* on the barrel were quite undisturbed, and a fine straight line could be drawn so as to bisect every similar second mark. Professor Harkness was somewhat astonished and pleased with the result. I showed one or two sheets marked by this chronograph to Sir George Airy, Mr. Christie, Mr. Dunkin, and Captain Tupman, and I intended to show them at the meeting of the Society, but I unfortunately mislaid them. I have no doubt, however, these gentlemen will remember the exceeding precision with which the sheets were marked.

It may be said, however, that such great precision is unnecessary especially in astronomical chronographs, and that any of the ordinary means of obtaining moderately uniform rotation are sufficient for astronomical purposes. I shall be in a great measure inclined to agree with such an opinion, but not altogether, for these reasons. This Governor, which gives nearly perfect results, is simpler and cheaper than nearly all those which only aim at very moderate accuracy; and again, anyone who has had much to do with *reading off* chronograph sheets or fillets will, I am sure, agree with me that *time is saved enormously* where *a scale* of minutes and seconds can be applied to the register, which can only be done with confidence where the rotation has been uniform. In an Observatory where much transit work (especially in Zone-observing) is done with aid of the chronograph, as at Melbourne, any means by which *reading off* can be expedited is of much more value than many would be inclined to imagine. Again, a simple means of obtaining accurately uniform rotation will be of great value in driving siderostats, and in many physical and physiological experiments; and I do not imagine there would be any great difficulty in applying this method to governing the driving apparatus of Equatoreals, the uniform motion of which, I believe, yet remains a thing to be desired.

I have on the table an apparatus, a kind of Morse's telegraphic register, governed by a parabolic pendulum, which will illustrate my description. It is devised to draw a paper fillet over rollers with great uniformity for chronographic purposes.

On the Silvering of Glass by Inverted Sugar, for Optical Instruments and Experiments. By M. Adolphe Martin.

(*Communicated by Warren De La Rue, D.C.L., F.R.S.*)

Since my last publication of the process of silvering glass in *Les Mondes*, No. of 10th December 1868, I have found it useful to introduce the following modifications:—

We prepare four solutions, which, preserved apart, undergo no change:

1° A solution of 40 grammes of crystallised nitrate of silver, in a litre of distilled water.

2° A solution of 6 grammes of pure nitrate of ammonia, in 100 grammes of water.

3° A solution of 10 grammes of caustic potash (quite free from carbonate and chloride), in 100 grammes of water.

4° We dissolve 25 grammes of sugar in 250 grammes of water; we add 3 grammes of tartaric acid, and heat to boiling, which is maintained for about 10 minutes to produce the inversion of the sugar, and the solution is then allowed to cool. We then add 50 cubic centimetres of alcohol, to hinder any subsequent fermentation, and we dilute with water to make the volume half a litre if the silvering is to be done in winter, or dilute still more if it is to be done in summer.

We will take as an example the silvering of a mirror of ten centimetres diameter. On the surface of the glass, previously dusted with a brush of badger's hair, are poured a few drops of concentrated nitric acid, and, with the aid of a pad of fine carded cotton, free from extraneous substances, the glass is carefully cleaned, rinsed with water, and dried with a perfectly clean fine linen cloth. On the surface itself is made a mixture of about equal volumes of the potash solution (No. 3) and of alcohol, and this is used to clean the surface by means of a tuft of cotton. This liquid, of a somewhat syrupy consistence, has the property of wetting the glass without running off at the edge as other liquids would do. The surface thus covered is plunged into a vessel of tolerably pure water and well rubbed with a badger-hair brush to make the alkaline coating dissolve; the face is then turned downwards into a plate containing pure water, taking care that

between the surface and the bottom of the plate there is a layer of water of at least ½ a centimetre (which may be secured by supporting the mirror by three little wedges of wood or whalebone), and by a slight rocking we carry off the liquid of the preceding washing.

In a first graduated glass measure of suitable size we pour

15 cubic centimetres of the solution of nitrate of silver, No. 1.

15 cubic centimetres of the solution of nitrate of ammonia, No. 2.

Into a second glass measure :

15 cubic centimetres of the solution of potash, No. 3.

15 cubic centimetres of the liquid of inverted sugar, No. 4; and we pour this into the first glass.

This mixture is put into a small plate, and the mirror, which was left on the water, is brought rapidly and laid upon its surface. The mirror is kept at ½ a centimetre from the bottom, as was done with the water; and is agitated gently by means of wedging in a continuous manner. If the liquids have been well prepared, the transparency of the first mixture is not impaired on pouring into it the mixture of potash and sugar. This definitive liquid ought, at the end of about half a minute, to colour itself, first pinkish yellow, then a yellowish brown, at last ink black. At this moment the silver begins to deposit itself on the border of the plate, with the colour of platinum; the glass then becomes silvered, in a very regular layer, without marked mottlings; we go on agitating it from time to time, and when the liquid, which has become turbid and greyish, covers itself with flakes of brilliant silver, the operation is finished. The mirror is removed and carefully washed under a sufficiently abundant stream of water, and after pouring quickly some distilled water over the surface, it is placed upon its edge on folded blotting paper and allowed to dry thoroughly. The surface then appears brilliant, but covered with a light bloom, which is easily removed by aid of a pad of chamois leather having upon its surface a little fine English rouge. *But if the potash is well freed from carbonate and the surface well cleaned, the silvering is perfectly brilliant and polished under this bloom, and it is not necessary to insist upon rubbing it with the pad.*

The principal accidents which may happen by reason of the inexact proportions of the mixtures are as follow:—If in the mixture of the nitrate of silver and the nitrate of ammonia the quantity of this last is insufficient, there will be on the addition of the mixture of potash and sugar a brown precipitate. If it is in excess, the silvering liquid will indeed remain clear, but it will colour itself by passing through violet tints; the white light reflected at the surface of separation of the glass and the liquid, before the silver appears, is coloured violet, and the silvering then produced is slow, very thin, dull, yellow for transmitted

light, and it never attains a sufficient thickness. [When the ammoniacal solution is well proportioned the reflected image has brown tints; the silvering is produced at the end of about five minutes, and gives a layer which is blue by transmitted light, very brilliant by reflection]. Tints greenish by reflection, and persistent mottlings occur when the glass is not sufficiently cleaned. None of these inconveniences present themselves if the foregoing directions have been followed exactly. The presence of carbonate in the potash, if it is abundant, may give a white precipitate, which becomes very quickly coloured upon pouring in the sugar: the reducing action then takes place rather in the liquid than on the surface of the plate; even in small quantity the carbonate gives rise to dull flakes on the silver film, and the rubber never polishes them well.

The degree of concentration of the solution of silver is also important. If too weak, the action is slow and incomplete, but it is easy to increase the quantity during the course of the operation. If too strong, the action is too quick, and the reduction of silver takes place chiefly in the liquid; it is very difficult to moderate it. It is always proper to make a preliminary trial, inasmuch as the concentration of the reducing solution should vary with the exterior temperature. Lastly, in removing the mirror from the water in order to plunge it into the silvering solution, care must be taken that the water does not run off from the edge: the effect would be to produce on the circumference spots of dull and badly adhering silver.

Half-Silvering.—M. Léon Foucault has also, for certain experiments, proposed the process which he calls *half-silvering*. He accomplished it by his old process, and applied it specially to the observation of the Sun by aid of a refractor. The exterior surface of the object-glass which has received this half-silvering reflects into space the greatest part of the calorific rays, while the luminous rays continue their course so as to give rise to the ordinary image. The temperature of the image of the Sun furnished by such a glass is raised so little that a coloured glass introduced to diminish at pleasure the luminous intensity is not injured, as it would be if the object-glass were unsilvered.

The half-silvering may be obtained by the foregoing process, by stopping the operation as soon as the silver begins to appear upon the glass. The glass is removed out of the bath, washed well with water, and dried; but the rubber must not be applied. A few trials will show at what moment the glass should be taken out in order to obtain a silvering to reflect more or less light at the expense of the transmitted light.

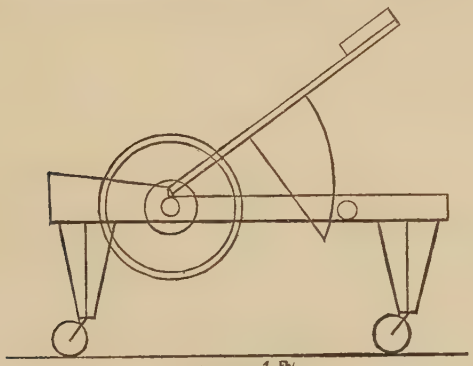
(Extracted from *Les Mondes*, No. of 17th June 1875.)

A New Form of Observing Chair. By Wentworth Erck, Esq.

This chair has now been in use some years, during which it has given entire satisfaction. It has all the advantage of a screw motion in raising the head through very small distances, while it has the great advantage of admitting of instantaneous motion through large arcs, which the screw does not. It has the further advantage of simplicity and economy.

The frame of the chair consists of a parallelogram about 42 × 21 in. and 4 inches deep, supported on French castors at a convenient height.

Twelve inches at one end of this frame is sheeted over to form a seat, and to this seat the movable back is strongly hinged.



Scale $\frac{1}{20}$ th.

This back carries, at 20 inches from the hinges, two arcs of a circle 20 inches radius, and of any desired extent provided the sine of the arc does not exceed the height of the chair. These arcs are made of strong hoop-iron bent to the required curvature. To the vertex of each one end of a leather strap is firmly screwed, whilst the other end of the strap is secured to a loose roller about 3 inches diameter, placed across the frame immediately behind the arcs.

Now it is evident that if this roller be made to revolve, the effect will be to wind up, or lower, the back by means of the attached arcs.

But the roller, being in a position inaccessible to the observer, is connected by saddle-girth web to another roller in a convenient position near the front of the chair.

The axis of this second roller passing through the frame carries at each end a wooden wheel about 15 inches in diameter, having a thickened edge for convenience of handling. There is also fixed on this axis a ratchet wheel 6 inches in diameter, with a pawl so placed as to be easily released by the observer. It is

clear that by releasing the pawl and pressing on the back of the chair, it will be instantly depressed through any angle; and on the other hand, by spinning round the wheel, the back, if relieved from weight, can be instantly raised through any desired angle.

If the diameter of the rollers and large wheel be respectively $2\frac{1}{2}$ and 15 inches, then a motion of the circumference of the wheel through a quarter of an inch will raise the observer's eye about one-sixteenth of an inch, corresponding to a space of a tenth of an inch between the teeth of the ratchet wheel.

The front edge of the chair should be slightly raised to prevent the body slipping forward when the back is inclined at certain angles.

For a telescope whose eyepiece is 5 feet from the Declination axis I use two of these chairs with seats at different heights, and when my feet are off the ground pull myself into approximate position by a strap hooked on to some convenient fixture.

Sherrington, Bray, Co. Wicklow,
1875, December.

On Celestial Photography. By Prof. Zenger.

Professor Zenger, in a letter dated Prague, November 10, 1875, writes that he has succeeded in very greatly reducing the time of exposure in celestial photography by employing "aplanatic objectives or mirrors of large aperture." He uses a new correcting achromatic lens in combination with mirrors of large aperture and very short focal length, so as to reduce the focal length to four times the aperture.

Professor Zenger also made use of the observations in the pure air of the Engadine. He states that with these arrangements he is able to get, every day that the Sun is sufficiently bright, photographs in which the corona presents itself as "a bright circular ring with the protuberances in it, if there are any. The ring on an average 1^m in height, and only in exceptional cases of nearly 2^m, and an excentricity amounting to only $2''$ or $3''$ of arc." "There is a fainter ring with broken outer layers, though often with sharply edged outlines.

"Careful observations of the Sun with my short focal refractor have shown the possibility of viewing directly the inner and most brilliant ring, if there be a coloured glass of a greenish yellow tint used.

"I cannot say whether this ring of nearly $30''$ (it passes the filar micrometer in 2^s nearly) be the chromosphere itself, or the most brillant inner layer of the corona next the Sun, but I and Professor Jafauk, to whom I showed it, saw it all round the Sun as a nearly spherical ring of scarcely perceptible excentricity to the Sun's centre.

"I therefore would regard it as the most brilliant part of the

solar corona next to the Sun's disk, and showing no sharp outline, but fading away with a very rapid decrease of brilliancy."

And in a subsequent letter, dated Prague, November 17, 1875, he has sent to the Society some copies of photographs of the Sun made by him at the beginning and end of the stormy period beginning November 6, at 6^h mean time of Prague, and ending at night, November 14.

Dates of Photographs.

		h m	
1	Nov. 6	3 0	Busch's Refractor.
1, 2	Nov. 6	3 30	Steinheil's Aplanatic.
3, 4	Nov. 14	2 20	,, ,,
5, 6	Nov. 14	2 35	,, ,,

Remarks upon two Papers by Colonel Tennant. By the Rev. Prof. C. Pritchard.

In the last Number of the *Monthly Notices* Colonel Tennant has done me the honour of referring to two articles of mine communicated to the Royal Astronomical Society. These remarks, arising from so eminent a source, require a respectful consideration from myself.

The first relates to the mode of obtaining a bright and steady image of a star, or of a wire, by reflection from quicksilver; and Colonel Tennant implies that he found some difficulty in the application of the method which I proposed in the *Monthly Notices* for January 1853. On the other hand, after long and varied experience, we find the constant application of the method not only a convenience, but even a luxury, in observations. If Colonel Tennant will do me the favour of consulting my paper he will find that the chief requisites for ensuring success are three. First, the amalgamation must be perfect; and for this end it is absolutely necessary that the surface of the copper should be clean, that is to say, it must be copper, and neither dust nor grease. Secondly, the pond of mercury must be shallow throughout, and in no part exceed (say) one-twentieth of an inch in depth. Thirdly, some ready means must be provided for skimming from the surface the very objectionable film which inevitably rises to the top, and which is due to the mere fact of amalgamation. These means are described fully in my paper, and I attribute the failures which have arisen in the adoption of the method to the non-observance of these simple but necessary precautions.

With us at Oxford the whole operation of renewing a faultlessly bright and steady reflecting surface is the work of less

than two minutes, and the surface is then so stable, and the cessation of all tremor so rapid, that we are annoyed neither by the presence of persons in the room, *nor by wind*, nor by the passage of heavy vehicles at a distance of three hundred yards. Our support for the mercury-trough, in the case of one of the instruments, is simply an iron frame, the four legs of which, after striding across the base of the instrument, rest on the stone pier.

I remember that on one occasion an eminent firm of opticians having been requested to adapt this method to a very large transit instrument, despatched a copper vessel of the dimensions of an ordinary copper preserving-pan; moreover, the bottom had been most carefully planished, and not without oil. The Nemesis was the abandonment of the method altogether.

Like many other presumed inventions, I find that I have been anticipated; but, as I at present believe, only partly so. Mr. Marth states that this method of a shallow amalgamated copper vessel was in use at Königsberg while he was a student there under the illustrious Bessel. But, as the vessel was *cup-shaped*, it seems to me a highly inconvenient form for skimming away the film, and ill adapted for the rapid destruction of tremors.

Colonel Tennant, in the same Number of the *Monthly Notices*, refers to an Ephemeris of twelve close circumpolar stars, which issued from the Oxford University Observatory in January of the present year. He complains of the smallness of the stars. Certainly I regret with him that no brighter stars exist in close proximity to the pole; but, on the other hand, I think that eleven out of twelve of these stars are not much inferior to the seventh magnitude, and are described by the late Mr. Carrington in his Redhill Catalogues as visible with a telescopic aperture of one English inch; and they are in constant use for determining the azimuthal error of the Oxford transit instrument with an aperture of less than four inches. Inasmuch as these stars are so selected that, together with those in the *Nautical Almanac*, two close circumpolars at an upper or a lower culmination are provided for every hour, I cannot but think that the arrangement must be very convenient in any Observatory where the assistants are few. I regret that I cannot entirely agree with Colonel Tennant that (even in such a latitude as that of Madras) the azimuth error of a transit instrument can be as accurately obtained from the observation of stars within twelve degrees of the pole as from an Ephemeris of far closer though fainter stars, such as that which we provided at the University Observatory.

The November Meteors. By the Rev. S. J. Perry, F.R.S.

The weather this year was unfavourable for observing the November meteors, except on the nights of the 11th and 14th. On the 11th, between $13^h\ 30^m$ and 18^h, the sky was very clear, but the moon was full. The only meteors seen were five of the first magnitude, one second, and three fourth. Only two of these were Leonids.

On the 14th the night was somewhat cloudy, but a watch was kept from 10^h till $16^h\ 30^m$, and the following meteors were seen :—

Between	h 12 and	h 13,	3 meteors,	1 of which was a Leonid.	
„	13 „	14,	3 „	none of which were Leonids.	
„	14 „	15,	9 „	4 „	„ „
„	15 „	16,	5 „	1 or 2 „	„ „
„	16 „	16.30,	4 „	all „	„ „

The meteors were all from first to fourth magnitude, the moonlight being too strong for others.

The paths of all the meteors seen were carefully noted.

Stonyhurst Observatory,
1875, *December* 7.

On the Double Star 61 *Geminorum.* By the Rev. S. J. Johnson.

I examined this object with a 4-in. Wray on the night of December 5, the air being very clear and steady. Powers of 300 and 420 brought out the faint companion as a glimpse object. The companion of δ *Geminorum*, rated at the same magnitude by Smyth, and of a more dusky colour and difficult to observe, was quite easy to it. Not having a micrometer, I turned the instrument on δ *Orionis* by way of comparison in point of separation; but the components of 61 *Geminorum* were certainly somewhat wider than this, perhaps about 60″ apart, as Smyth states. Position-angle by estimation about 180°. It seems, therefore, much in the same state of brightness as when Mr. Sadler observed it last spring. Its magnitude now is about the same as that of the distant comes to *Aldebaran*. Owing to the distance agreeing tolerably well, may we not infer that this is the actual object observed by Smyth, that he recorded the angle of position erroneously, and consequently that variability need not be suspected? There are many instances of his marking magnitudes incorrectly, as for example γ *Delphini*.

Upton Helions Rectory, Crediton,
December 7.

Discovery of Minor Planet (157).

Another member of the Minor Planet group was discovered at Marseilles by M. Borrelly on December 1, 1875, at $10^h\ 30^m$ P.M. It was of the 12–13 magnitude. The following is its observed position on the evening of discovery:—

	Mean Time at Marseilles.	R.A.	l.f.p.	N.P.D.	l.f.p.
1875.	h m s	h m s		° ′ ″	
Dec. 1	12 8 39	4 22 4·00	+8·763	66 1 32·0	−0·4699

The planet was compared with W.B. (2) IV. 419–20, a star of the $8\frac{1}{2}$ magnitude, whose mean position for 1875·0 is—

R.A.	N.P.D.
h m s	° ′ ″
4 20 47·95	66 9 47·6

The hourly motion of the planet was found to be $-3^s{\cdot}10$ in R.A., and $-16''{\cdot}0$ in N.P.D.

1875, *December* 10.

ERRATA.

Pages 8 and 9. The figures called 2 and 3 should be 3 and 2 respectively.

Page 40. For Mr. Noble read Mrs. Noble.

,, 41. The figure is reversed, right for left; it should be held before a looking-glass to present the effect as viewed in the telescope.